Space Weather Technical Forecast

Issued on Tuesday, 18 January 2022 at 00:48 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight Chance of G1 Thursday 20 January from re-analysed 16 January CME. Chance of isolated M-class flares (R1/R2 radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low through the UTC day of Monday 17 January. X-ray activity measured at GOES 17 saw a double-peak long-period C2.8 X-ray flare from sunspot region AR2930 at 17/1414UTC, potentially triggering an adjacent filament lift off peaking at C2.7 at 17/1516UTC. The ejecta from this event was clearly visible in coronagraph imagery to end the UTC day, angled above and ahead of the Earth in its orbit. This was the only Coronal Mass Ejection (CME) event of note visible in coronagraphs for the period.

There are now six sunspot regions on the visible disc, with the unipolar AR2925 having faded from view near the southwestern limb, while active regions 2931, 2927 and 2932 saw out the period on the disc and were all also unipolar and stable. Of the bipolar regions, AR2933 near the meridian in the southern solar hemisphere showed decaying trailer penumbrae to end the 24 hours as a Cai/Beta. AR2929 in the northwest was the largest group in terms of area, however it shrank, showed consolidation and also showed a trend towards becoming more symmetrical and open, nevertheless ending the period as a Dko/Beta. This left 2930 in the northwestern quadrant as the most noteworthy and active spot, with some proliferation visible in its intermediate spots, although overall areal decay was observed. This group was assessed as a Dai/Beta in the UTC evening of Monday.

The CME from 14 January is now considered to have passed 1AU to no effect at Earth and has been removed from the forecast. The C2 flare from AR2929 on 16 January produced a CME directed mainly to the northwest. This has been re-analysed and may pass Earth as a glancing blow on Thursday 20 January.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1 was symptomatic of connection to a high speed stream, thought to be that emanating from CH44/-. The solar wind speed was elevated and near-level at 550km/s, with a brief lull to nearer 500km/s seen during the early UTC evening. The solar wind density was slightly elevated into the low double figure of ppcc, possibly with a slight decline evident, although measurement differences between ACE and DSCOVR contributed to the erratic trace. The IMF was mainly near 5nT but with a late peak to 8nT, while the north-south component varied between -7 and +6nT. The phi angle was mainly negative (towards the sun) but with some brief forays into a positive sector.

The net result of the above solar wind measures was provisionally Quiet to Unsettled Kp activity, peaking early and late, with the highest observed figure being Kp 3+ in the 00-03UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 remained at Background levels throughout.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

High energy electron flux (greater than 2MeV) measured at GOES 16 was at Moderate to High levels in the diurnal cycle, with a peak value of 2020pfu at 17/1855UTC. Electron fluence rose over the 24 hours, with an 18/0000UTC observed value of 8.94e7 integrated pfu recorded.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, with the daily risk of significant flares revised slightly downwards relative to recent guidance given the observed lack of activity and simplifying front-sided sunspot groups. Having said this, the slightly rising trend remains in the four days, with a daily Chance of M-class flares - the result of the potential arrival of further active regions over the southeastern limb in the period.

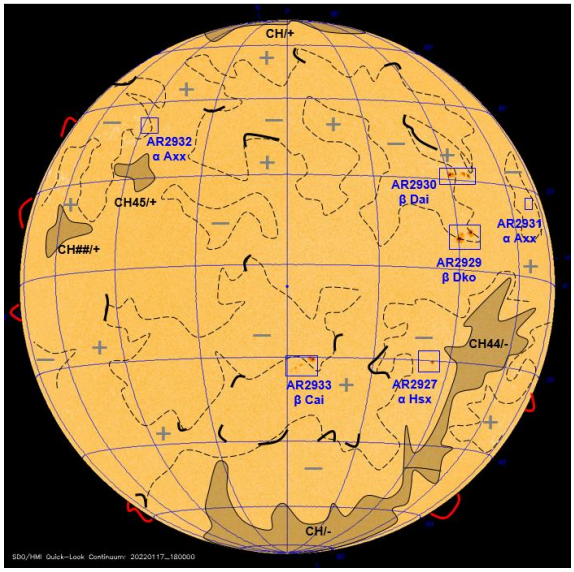
Solar Wind / Geomagnetic Activity: A CME associated with a filament lift-off on the afternoon UTC of 14 January is now considered most likely to have passed 1AU to no effect at Earth and is removed from the forecast. The CME from the C2 flare from AR2929 on 16 January may carry an Earth-directed component, with a possible glancing blow arriving in the UTC day of Thursday 20 January. This gives perhaps a Slight Chance of G1 within this UTC day.

Otherwise, the only coronal hole feature due in the four days is expected to be the current one, CH44. A gradual decline toward a slow regime is therefore expected from midweek, with (excepting the 16 January transient) increasingly Quiet geomagnetic activity expected from an initial Chance of Active.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at Background levels.

The high energy electron flux (greater than 2MeV) is expected to be stabilising, with a current oscillation between Moderate and High flux expected to continue. This puts 24-hour fluence as marginal for surpassing the Active threshold, but perhaps remaining just below, and hastening should the 16 January CME arrive.

Figure 1. Solar Analysis Valid 17/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

A CME associated with a filament lift-off on the afternoon UTC of 14 January is now considered most likely to have passed 1AU to no effect at Earth and is removed from the forecast.

The CME from the C2 flare from AR2929 on 16 January has been re-analysed and is now considered to perhaps carry an Earth-directed component, as suggested by some MOSWOC Enlil Ensemble members. These point towards arrival early in the UTC day of Thursday 20 January, with a resultant Slight Chance of G1 proffered, but with low confidence. This analysis exclusively considered the portion of ejecta seen heading northwest on Lasco coronagraphs (also correlated with STEREO A COR2 data). There were also hints of material seen heading north and northeast on Lasco C2 at the same time - the attribution for these streams is not clear, however it is possible that they were produced in the same event, and this was therefore more of a partial halo CME. This uncertainty has influenced the inclusion of the northwestward portion in the forecast as a Slight Chance of G1, however it remains that confidence is low for the event as a whole.

The only coronal hole feature due in the four days is expected to be the current one, CH44, which is now mature, with resultant geomagnetic activity very likely to have already peaked. A gradual decline toward a slow regime is therefore expected from midweek, with no further enhancements (barring the above transient) expected.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

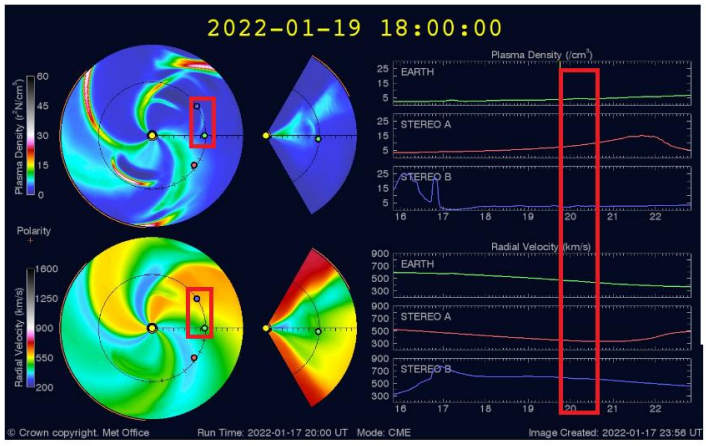
Geomagnetic Activity - Earthbound Coronal Mass Ejections

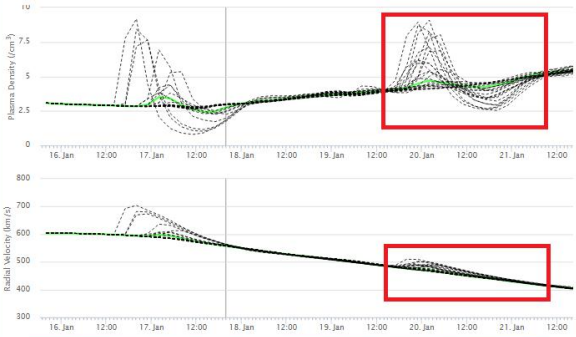
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/0235UTC	Partial?	C2 flare from AR2929 on 16 January	NW quadrant	562km/s	20/0000UTC	Low confidence, glancing blow

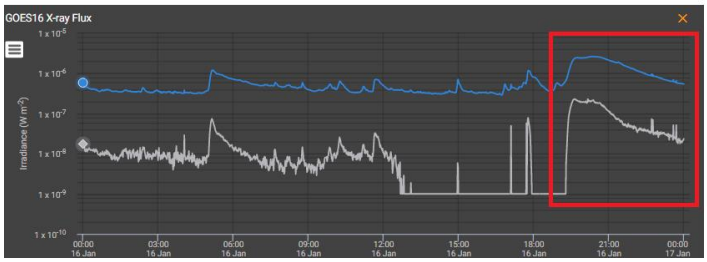
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

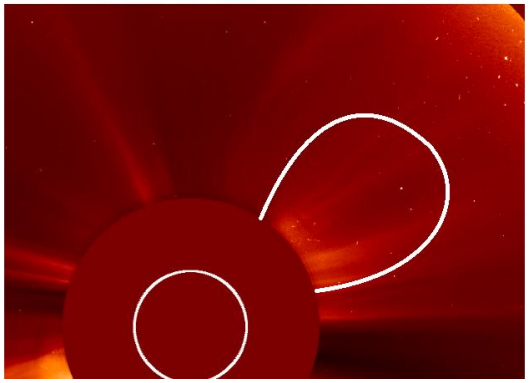
© Crown Copyright 2022. All Rights Reserved.

Figure 2: Clockwise from top left: Latest available MOSWOC Enlil run with ensemble. The 16 January C2 CME from AR2929 can be seen red boxed. The deterministic run is a very faint glance, however (top right) there are a significant number of ensemble members with 'thicker' hits inside the UTC day of Thursday 20 January. Because of this, and the fact that some ejecta can be seen heading north and northeast on Lasco C2 coronagraph imagery for the relevant period (main ejecta outlined in white on C2 image 16/2220UTC lower right), overall a Slight Chance of G1 is suggested. Also shown, lower left is the GOES 16 X-ray trace for the event. Confidence remains low for this event.









Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

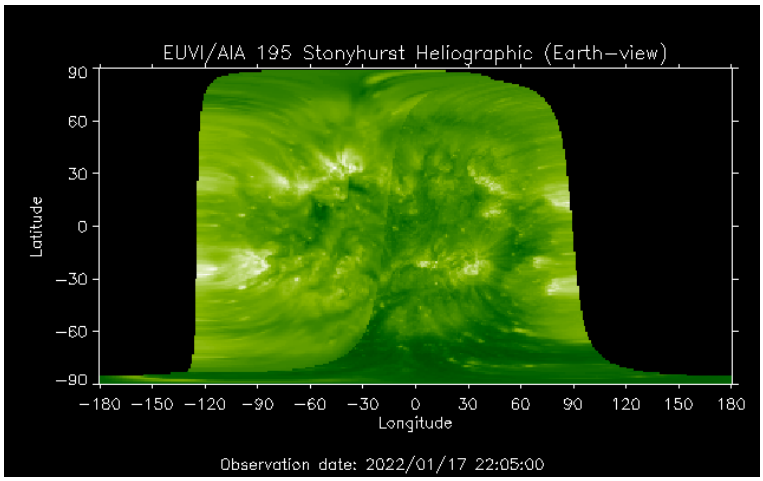
Radio Blackouts - X-Ray Flares:

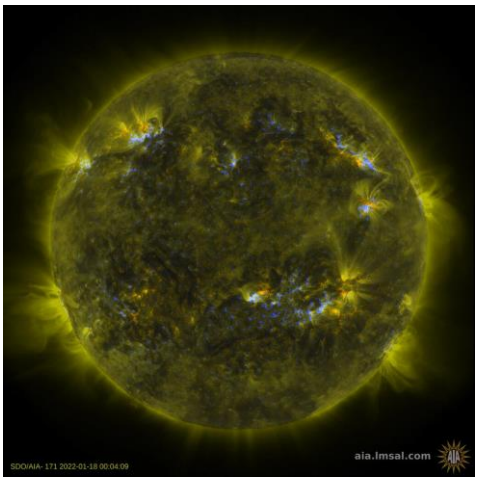
The overall trend in the six front-sided sunspot groups has been of stability or slight decline in the past 24 hours, with recent activity confined to low C-class. The more significant regions on the disc all occupy various positions in the western solar hemisphere at present, however none leave the disc in the four-day period. This means that the prospect of returning regions arriving over the southeastern limb in the period should bolster the risk of flares, although the degree to which this occurs remains to be seen. The westernmost of these may now lie on the limb itself, however the background X-ray flux recorded at GOES 17 remains unmoved, perhaps suggesting .

Relative to recent guidance, the daily risk of M and X-class flares has been revised downwards, but with the token slight uptick in risk maintained for the arriving group(s).

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	20	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Left: Cylindrical projection of the sun in EUV, showing potential large arriving plage or active regions in the southern solar hemisphere. Right: Composite of AIA171 and HMIBC imagery, showing possible correlating flux loops to the newly arriving regions in the lower left of the image. The X-ray flux recorded at GOES 16 is as yet unmoved.





Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 remains at Background levels. The weight of sunspot groups and activity in the western solar hemisphere is leading to a raised risk of S1 in the coming four-day period, although the effect is very slight.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) saw a roughly equal amplitude diurnal oscillation in the past 24 hours to the preceding 24, indicating that the response to the ongoing high speed stream from coronal hole 44 may now be mature. 24-hour integrated fluence remains very near the Active threshold, however on balance may be considered most likely to turn narrowly short of the mark and ebb away in the ambient solar wind conditions expected to follow later this week. Confidence drops markedly with the potential complication of the 16 January CME passing Earth on Thursday 20 January.

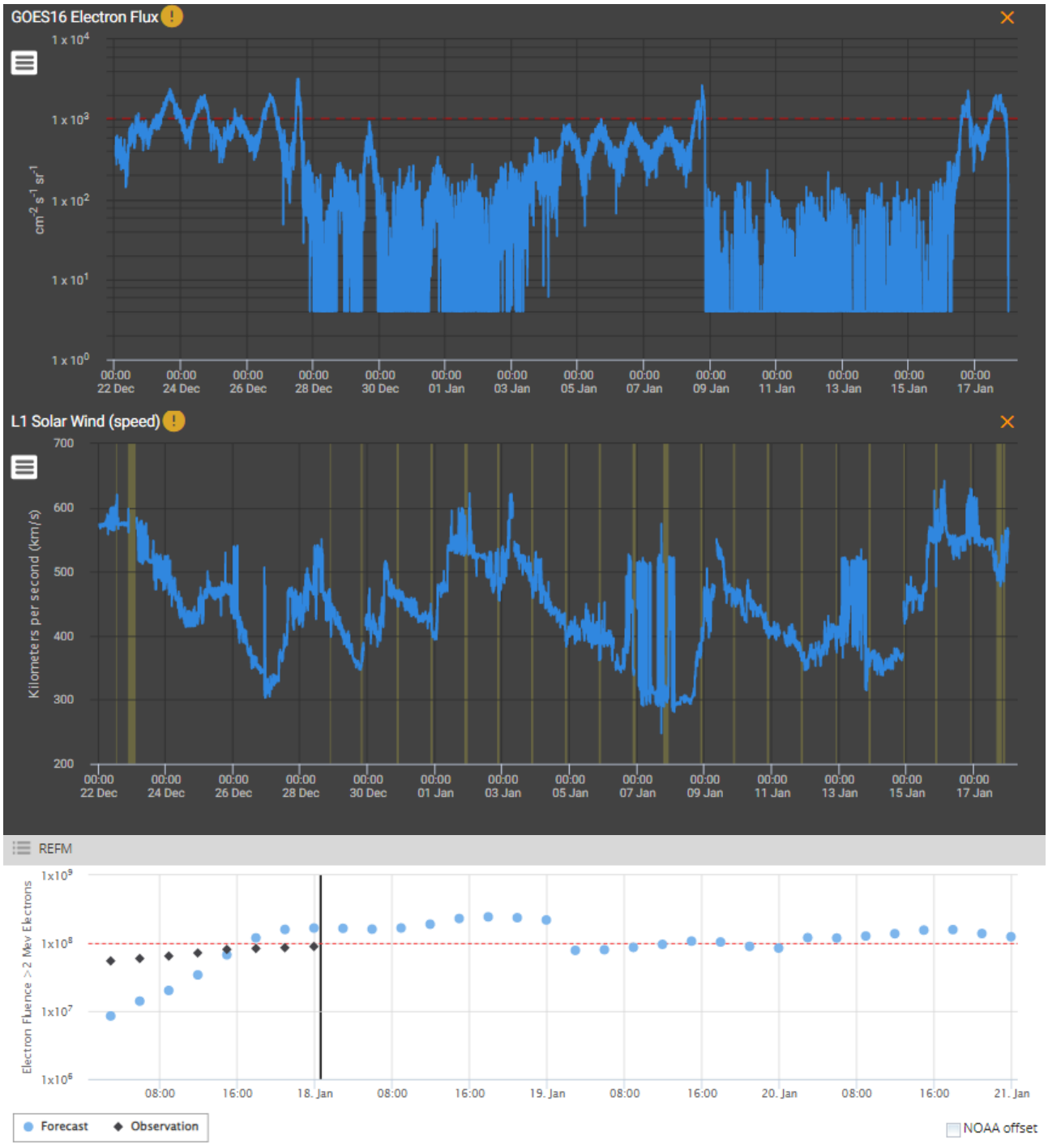
The current level of response in high energy electrons is very similar to that seen on last rotation in reaction to CH44's predecessor. REFM is considered to be offering good guidance at present, which unfortunately means an almost level trend along the 1e8 threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	40	40	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 4: Past month in GOES 16 high energy electrons (top) and solar wind speed at L1 (middle). There is a strong correlation between current flux levels and those seen on last pass of CH44, lending confidence to the marginal 1e8 integrated pfu fluence values suggested by the latest MOSWOC REFM run (bottom).



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.